Accordingly, a lowered hardness might cause a transformation from a severe wear mechanism, to a milder wearing. Another important parameter, that will also strongly affect the threshold load and determine the wear rate, is the fracture toughness (a measure of the resistance to cracking). We have not taken the fracture toughness into consideration in this investigation, however, there might be possible toughening effects due to the three postulated different occurrences of iron in the pigmented enamel.

Both the pigmented and the unpigmented enamel of all specimens show large local variations in hardness. The nanoindentation hardness for a 100 nm deep indent usually is 6–9 GPa or 0.1–0.4 GPa depending on which region measured. The variation in the results may be explained by different forms of iron in the pigmented enamel, by varying composition of the apatite crystallites, by a varying degree of crystallinity in the enamel as well as by the local wear status. However, there is no clear difference in hardness between the pigmented and the unpigmented enamel, even though there is some tendency showing that the unpigmented enamel is slightly harder than the pigmented.

The nanoindenter system is well suited for this type of investigation since it can obtain information from near surface regions of the order of 1 μm. This particular material shows variations in the local properties larger than in synthetic hydroxyapatite, and uniformly polished surfaces and cross-sections would therefore be needed for a more thorough investigation.

Acknowledgements

We are indebted to the Swedish Museum of Natural History for providing us with specimens. Dr Kristin Breder and Dr Anders Angerbjörn are gratefully acknowledged for reading through the manuscript and giving their valuable suggestions. We would like to thank Nils Lange for commenting on the EDS work. Finally Mrs Bibbi Mayrhofer has helped us with part of the illustrations.

Zusammenfassung

Über die Härte von pigmentiertem und unpigmentiertem Zahnschmelz bei Spitzmäusen der Gattungen Sorex und Crocidura (Mammalia, Soricidae)

Die Härte des Zahnschmelzes in den Schneidezähnen von drei Spitzmausarten, *Sorex araneus, S. minutus* und *Crocidura russula,* wurde mit einem speziellen Gerät getestet, welches den Zahn einer äußerst geringen Belastung aussetzt. Zwei verschiedene Regionen wurden vermessen, die erst in dem vorderen Teil der Schneidezahnes (bei den *Sorex*-Arten mit pigmentiertem Zahnschmelz überzogen), die zweite in der hinteren, unpigmentierten Region desselben Zahnes. Es bestehen große lokale Unterschiede in den mechanischen Eigenschaften und mögliche Ursachen dafür werden diskutiert. Die Resultate bekräftigen keine Hypothese über Unterschiede in der Härte des pigmentierten gegenüber dem unpigmentierten Zahnschmelz. Es gibt jedoch eine Tendenz dahin, daß der unpigmentierte Zahnschmelz etwas härter ist als der pigmentierte.

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Z. Säugetierkunde 57 (1992) 330–334

ISSN 0044-3468

G-, C-bands and NOR studies in two species of bats from Southern Brazil (Chiroptera: Vespertilionidae, Molossidae)

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Receipt of Ms. 24. 2. 1992
Acceptance of Ms. 16. 6. 1992

Abstract

Described the karyotypes of two species of bats from Southern Brazil, *Eptesicus brasiliensis* (2n = 50; AN = 48) and *Molossus molossus* (2n = 48; AN = 54). The study of *E. brasiliensis* was based in seven males and seven females, while that of *M. molossus* included three males and 13 females. All autosomal chromosomes of *E. brasiliensis* are acrocentric, while *M. molossus* presents four pairs of submetacentric and 19 pairs of acrocentric chromosomes. Both species present an acrocentric Y chromosome; the X is submetacentric in *E. brasiliensis* and metacentric in *M. molossus*. The G-bands of *E. brasiliensis* do not differ markedly from those reported for other species of *Eptesicus*. *M. molossus*, however, presents a rather different G-pattern from those of other species of the same family. As for the C-bands, the results for both species are not remarkably different from those of other species of the same families. *E. brasiliensis* and *M. molossus* show a nucleolus organizing region (NOR) in only one pair, the one that presents a secondary constriction near the centromere.

Introduction

The bats present in the Southern Brazilian state of Rio Grande do Sul inhabit an area between two subregions of the Neotropical region, the Brazilian Highlands and Coast, and Patagonia. Eleven species of the family Vespertilionidae and eight of the Molossidae have been reported to live in the state (Silva 1985). This work deals with *Eptesicus brasiliensis* (Vespertilionidae) and *Molossus molossus* (Molossidae), bats which are distributed over all South America (Koopman 1982). Previous studies on these species report a diploid number (2n) equal to 50 for *E. brasiliensis* (Ando et al. 1977; Williams 1978; Bickham 1979; Volleth 1987), and 2n = 48 for *M. molossus* (Baker and Lopez 1970; Warner et al. 1974), but no chromosome bands or NOR observations were made on them. The objective of this study was to fill this gap in our knowledge.

Material and methods

Fourteen specimens of *Eptesicus brasiliensis* (Desmarest, 1819) were studied, seven males and seven females from Fazenda Caçapava, in Taim's Ecological Station (32° 32′S; 52° 32′W). The sample of *M. molossus* (Pallas, 1766) is constituted by 16 specimens, two males and 10 females from this same place, one male from Porto Alegre (30° 10′S; 51° 15′W), and three females from Torres (29° 21′S; 49° 46′W), all localities in the Brazilian state of Rio Grande do Sul.

Lee and Elder's (1980) technique was employed in the bone marrow chromosome preparations. The G-bands were induced following Seabright's (1971) method with the modifications proposed by Patton and Baker (1978), while the C-band patterns were obtained with Sumner's (1972) technique. The NOR observations were made using Howell and Black's (1980) method.

Results

Eptesicus brasiliensis presented 2n = 50 with an autosomal arm number (AN) equal to 48. Figure 1a shows the standard karyotype of this species. All the autosomes are acrocentric, roughly classifiable in large (pairs 1 to 15), median (pairs 16 to 21), and small (pairs 22 to 24) chromosomes. The X is a median submetacentric and the Y is a small acrocentric. Figure 1b presents the patterns of constitutive heterochromatin for this species. There are well defined, small C-bands in pairs 3 to 8, 10 to 13, 16, 18, 20 and 21, representing 58 % of the autosomes with marked centromeres. The X chromosome also has a C-band, while the Y is totally heterochromatic. G-bands are shown in Figure 1c, while Figure 1d presents the nucleolar organizer region in pair 14, which has a secondary constriction near the centromere (Fig. 1a).

M. molossus has 2n = 48 and AN = 54. Conventional staining (Fig. 1e) shows four pairs of submetacentric chromosomes, pair 1 being the larger; the other three are median submetacentrics, while the remaining autosomes are all acrocentric. Pairs 22 and 23 are very small compared to the rest of the karyotype. The X chromosome is a median metacentric, a little larger than pairs 2–4, while the Y is a small acrocentric. C- and G-band patterns are shown in Figures 1f and 1g, respectively. C-bands occur in almost all autosome pairs, the exception being pair 7, and in the X. The nucleolar organizer region (Fig. 1h) occurs in pair 8 at the secondary constriction near the centromere.

Discussion

Eptesicus brasiliensis

The genus *Eptesicus* comprises about 30 species worldwide (Emmons 1990). Approximately 50 % of them present 2n = 50 and AN = 48 (Ando et al. 1977; Williams 1978; Zima 1982; Volleth 1987; Varella-Garcia et al. 1989), but others show reduced chromosome numbers (for instance, *E. capensis* with 2n = 32, AN = 50; *E. zulensis* with 2n = 28, AN = 48). Species with different chromosome numbers, however, are morphologically similar (McBee et al. 1986; McBee et al. 1987; Morales et al. 1991). We found 2n = 50 and AN = 48 for *E. brasiliensis* from Rio Grande do Sul, thus agreeing with Bickham (1979) who found the same numbers studying specimens from the Nearctic region.

No remarkable differences were found between the G-bands presented here and those found by Zima (1982) in *E. nilssoni*. This fact, and the relative constancy in chromosome numbers, demonstrates that this genus is chromosomically conservative. In relation to the C-bands, we found only 58 % of autosome pairs marked, while Ando et al. (1980) determined low quantities of constitutive heterochromatin for other species of Vespertilionidae. Only pair 12 of *E. brasiliensis* showed a nucleolar organizer region, in accordance with the findings in *E. serotinis* (Volleth 1987).

Molossus molossus

Five diploid numbers were reported within the family Molossidae: 2n = 34, 38, 40, 42, and 48 (Baker et al. 1982; Varella-Garcia et al. 1989). The 2n = 48 karyotype is the most frequently found. Warner et al. (1974) found 2n = 48 and AN = 58, while Baker and Lopez (1970) reported 2n = 48 and AN = 56 for *M. molossus* of North and Central America, respectively. We observed 2n = 48, AN = 54. This suggests variation due to pericentric inversions, but since no banding was performed in these earlier studies, we cannot be sure about that.

For the C-bands, our results are not too different from those reported by Morielle-Versute et al. (1991). These authors studied two species of the genus *Molossops: M.*

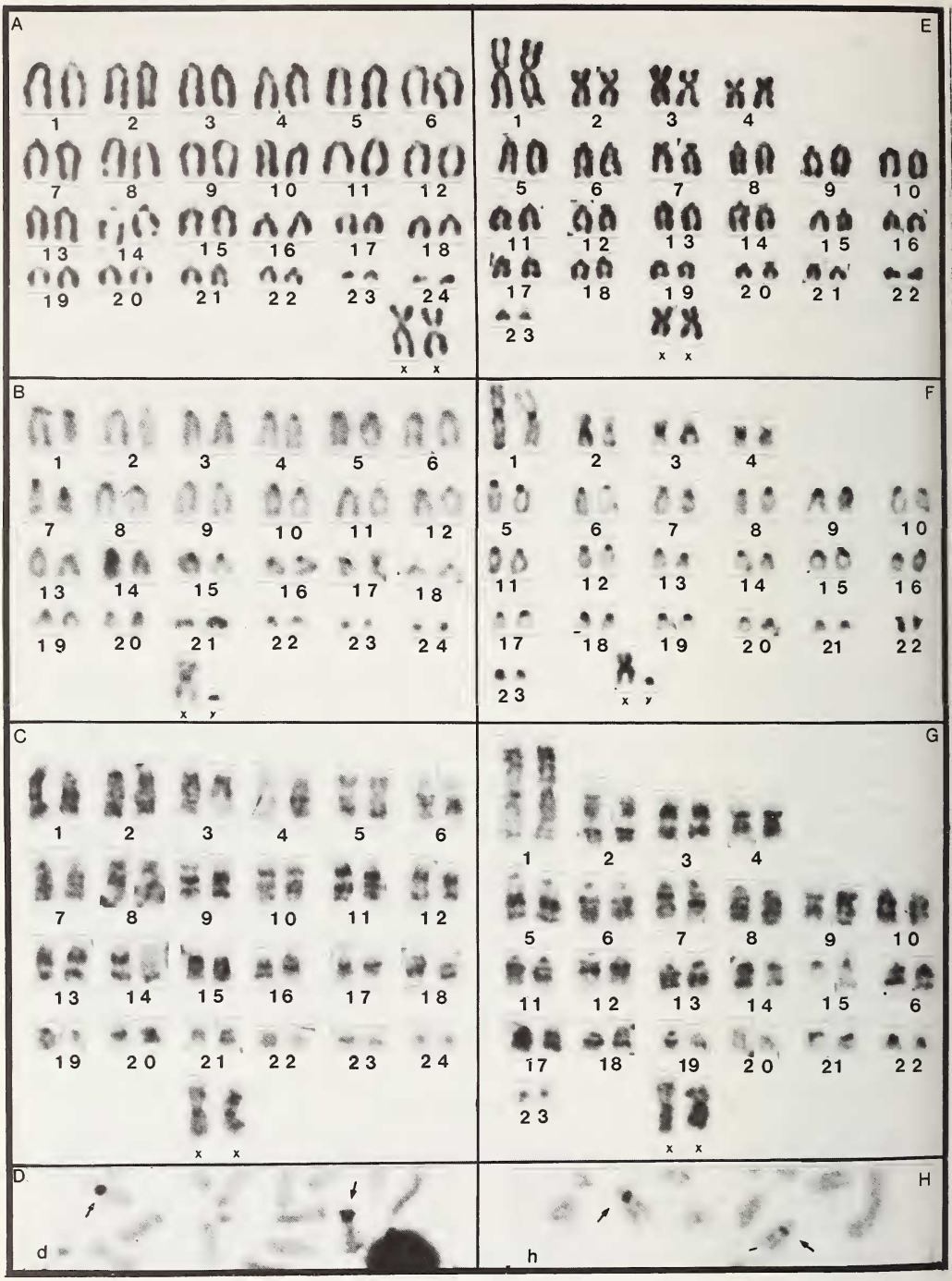

Fig. 1. Chromosomes of *E. brasiliensis*. A: Standard bone marrow Giemsa stained karyotype; B: C-bands; C: G-bands; D: NOR identification. E–H: Chromosomes of *M. molossus*. E: Giemsa stained karyotype; F: C-bands; G: G-bands; H: NOR identification